REMARKS/ARGUMENTS

Upon entry of this amendment, which amends claims 47-48 and adds new claims 97-120, claims 47-120 remain pending. Previously examined claims 57-59 and 74-76 were objected to due to certain informalities; claims 46-49, 50-52, 60-65, 67-73, 84, 86-87, 89, and 92-95 were rejected under 35 U.S.C. 102(e) as being anticipated by USPN 5,689,128 to Hshieh et al. (hereinafter Hshieh '128); and claims 53, 59, and 74-83, 85, 88, 90-91, and 96 were rejected under 35 U.S.C. 103(a) as being unpatentable over Hsheih '128 in view of USPN 6,204,533 to Williams et al. (hereinafter "Williams '533"). Reconsideration of the claims in view of the above amendments and the comments below is respectfully requested.

Drawing Objections

The drawings have been objected to under 37 C.F.R. 1.83(a) for failing to show every feature of the invention recited in the claims. Specifically, the objection has required Applicants to show the termination trench structure or cancel corresponding claims. Figure 2B has been added to illustrate the claimed trench termination structure that was described in the specification as originally filed, for example, at page 7, lines 32 *et seq.* The specification has also been amended to reflect the addition of Figure 2B. Applicants submit that no new matter is introduced by the amendments to the drawings and the detailed description. Applicants point out that support for this amendment can be found not only in the detailed description section of the application as originally filed, but also in USPN 5,430,324, which was incorporated by reference at page 8, lines 5-6, of the application for the specific purpose of further elaborating on the trench termination structure. Applicants believe this amendment addresses the objection to the drawings and respectfully request withdrawal of the objection.

Claim Objections

Claims 57-59 and 74-76 have been objected to because of certain informalities. Specifically, the Action states that because "neither the drawings nor the specification discloses"

the claimed trench termination structure, "the Office assumes that the Applicants mean the trench is same as the well, well 40, for example." Applicants respectfully disagree and submit that the specification as originally filed clearly describes the use of trenches to form the termination structure. The specification as originally filed provides, for example, starting at page 7, line 32 (paragraph 34 in the substitute specification):

> It is noted that, as an alternative to steps 4-4c, a suitable field termination structure can be formed using a ring-shaped trench which surrounds the periphery of the cell array and acts to lessen the electric field and increase the resistance to avalanche breakdown degradation. This trench field termination does not require a field oxide or deep p+ body junction to be effective. Consequently, it can be used to reduce the number of process steps. Using a trench ring (or multiple concentric trench rings) to form a field termination is described in, *e.g.*, U.S. Patent No. 5,430,324, the full disclosure of which is hereby incorporated herein by reference. Preferably, the trench would have substantially the same depth as the trenches in the cell array.

It is believed that the amendments made to the drawings and the specification address the objections raised by the Action. Withdrawal of this objection is therefore respectfully requested.

Claim Rejections - 35 USC § 102

Claims 46-49, 50-52, 60-65, 67-73, 84, 86-87, 89, and 92-95 were rejected under 35 U.S.C. 102(e) as being anticipated by Hshieh '128. With respect to independent claims 46 and 67, the rejection states that Hshieh '128 discloses all of the claimed elements including "a doped heavy body region 36 ... wherein the heavy body region inherently forms an abrupt junction in the doped well." The rejection further asserts that "even though the cited reference does not mention the function of the heavily doped region as abrupt junction. However, the cited art discloses a structure of the device that is identical with the instant application's device. Therefore, the cited device is capable of performing functions and properties as currently claimed." Applicants respectfully traverse this rejection.

There are a number of fundamental differences between the devices disclosed in Hshieh '128 and the instant invention that distinguish the present claims. For example, contrary to the assertion by the rejection that "the cited art discloses a structure of the device that is identical with the instant application's device," every one of the three devices shown and described by Hshieh '128 has at least one significant distinguishing feature. Hshieh's Fig. 1 embodiment has a "P+ deep body region" (16) that is deeper than the well (14) and the trench (24). Col. 3, lines 1 *et seq*. Hshieh's Fig. 2 embodiment has a "P+ deep body region" (36) that is deeper than the well (14) and extends into "a second (upper) epitaxial layer (drift region) 34." Hshieh '128 therefore teaches in Fig. 2 using P+ deepy body region in a device with a "double epitaxial layer (drift region) structure." Col. 2, lines 63 *et seq*. In Fig. 3, Hshieh '128 discloses the same double epitaxial structure without any deep P+ body region. Col. 4, lines 14-23.

In contrast to the teachings of Hshieh '128, the present invention neither employs a P+ region that is deeper than the trench, nor a double epitaxial layer. Instead, the present invention employs, in one embodiment, a heavy body region (34) that is shallower than the trench (26) and forms an abrupt junction inside the well region (36). The claimed abrupt junction is a term of art that is understood by one skilled in this art to have certain properties that are distinct from a linearly graded junction. Applicants have successfully employed an abrupt junction as claimed which improves device breakdown voltage by moving the location of peak electric field away from the trench corners. Importantly, Hshieh '128 is concerned with the exact same problem associated with electric field near trench corners that cause destructive breakdown. See, *e.g.*, Hshieh '128, col. 1, lines 25-41; col. 2, lines 14-18; and col. 4, lines 17-24. However, Hshieh '128 clearly fails to contemplate the use of an abrupt junction and instead offers other types of structures such as deeper P+ body regions and double epitaxial layers to address the same problem.

Thus, contrary to the assertion made by the rejection, the structure of the device in Hshieh '128 is clearly not identical to the claimed structure, nor does Hsheih '128 "inherently" teach an abrupt junction. Indeed, to the extent that Hshieh '128 discloses other structures such as a P+ body region that is deeper than the trench and a drift region made of double expitaxial layers to improve breakdown voltage, Hshieh '128 teaches away from the use of an abrupt

junction. Both independent claims 46 and 67 recite in part "a doped heavy body region ... [that] forms an abrupt junction in the doped well." Hshieh '128 fails to teach or even suggest this feature in combination with the other elements of claims 46 and 67. Claims 46 and 67 are therefore patentably distinguished over Hshieh '128.

All remaining rejected claims depend from claims 46 or 67 and therefore derive patentability therefrom. These claims, however, recite additional features that further distinguish over the cited reference. For example, with respect to claims 48 and 68, the rejection asserts that Hshieh '128 discloses in Fig. 3 a doped well with a flat bottom. Fig. 3 of Hshieh '128, however, lacks any region inside the well that would correspond to the claimed "doped heavy body." P+ region 18 is defined by Hshieh as "contact region 18, to promote electrical contact between the body region 14 and the overlying source-body metallization layer 30." Col. 3, lines 38-40. Hshieh '128 therefore fails to teach or suggest the combination set forth in claims 48 and 68 that recite, in part, a "doped heavy body region" and a "doped well [that] has a substantially flat bottom." Also, with regard to claims 47 and 69, for example, not only is there no mention or suggestion by Hshieh '128 of an abrupt junction, Hshieh '128 fails to disclose or even remotely suggest adjusting the location of the abrupt junction relative to the well or any other junction in a way that would impact the location of the peak electric field. The rationale offered by the rejection as to how Hshieh '128 "inherently discloses" this feature is not understood. Certainly, Hshieh '128 did not contemplate such relationship between the location of the abrupt junction relative to the well since Hsieh '128 offers other types of structural modifications (deeper body or double-epitaxial layer) in an attempt to achieve similar results. Inventive features recited in other dependent claims similarly distinguish over the cited reference.

Thus, Hshieh '128 fails to teach or suggest the claimed doped heavy body structure and its various attributes in combination with the other elements as recited in claims 46-49, 50-52, 60-65, 67-73, 84, 86-87, 89, and 92-95. These claims are therefore patenably distinguished over the cited reference. Accordingly, withdrawal of this rejection is respectfully requested.

Claim Rejections - 35 USC § 103

Claims 53, 59, and 74-83, 85, 88, 90-91, and 96 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Hshieh '128 in view of Williams '533. The rejection essentially asserts that all claimed features not disclosed by Hshieh '128 are taught by Williams '533, and that it would have been obvious to combine the teachings of Hshieh '128 with Williams '533. For example, the rejection asserts that Williams '533 teaches, in fig. 3, "a deep well 316 that functions as a termination region surrounding the device," as well other features of the termination structure as claimed. Applicants respectfully traverse these and other rejections made by the Action.

As explained above, Hshieh '128 fails to disclose or suggest a transistor having, in combination with the other elements recited in the rejected claims, a doped heavy body region that forms an abrupt junction inside a doped well. Applicants submit that Williams '533 does not in any way cure this deficiency of the cited reference. In fact, similar to Hshieh '128, Williams '533 attempts to address the same problem of protecting the transistor from destructive breakdown with yet another, significantly different, structure. Williams '533 teaches forming "deep diffusion at periodic intervals throughout the cell lattice" to protect the gate oxide layer against breakdown voltages. See, *e.g.*, col. 3, lines 10-14. Thus, Williams '533 also teaches away from the claimed structure for a transistor with the recited doped heavy body junction. All rejected claims, therefore, are patentably distinguished over the cited references for at least the reasons discussed above.

Moreover, the combination of Hshieh '128 and Williams '533 fails to teach or suggest many of the other inventive features recited in the independent claims of the instant application. For example, in rejecting claims 59, 74, 76 and 78, the Action asserts that Williams '533, in fig. 3, discloses "a deep well 316 that functions as a termination region surrounding the device." Deep well 316 in fig. 3 of Williams '533, however, is clearly not a termination region and is expressly defined by Williams as a "protective diode cell" that is provided "in a repetitive pattern across the MOSFET." Col. 5, lines 8-10. Williams '533 provides: "In general, for example, MOSFETs which are expected to experience breakdown more often will require a

greater proportion of diode cells." Col. 5, lines 12-14. It is this exact same disclosure by Williams '533 that teaches away from the use of a doped heavy body in the manner claimed by the present invention to improve transistor breakdown voltage.

The combination of the cited references similarly fails to suggest other features of the termination structure as claimed by the present invention. For example, the cited references fail to suggest a termination structure with "a layer of dielectric material formed over the deep doped region; and a layer of conductive material formed on top of the layer of dielectric material." Dielectric layer 314 and metal layer 312 in Fig. 3 of Williams '533 are the gate protective layer and source metal, respectively. Col. 4, lines 39-46. Thus contrary to the rejection's characterization, these layers are unrelated to a termination structure.

In sum, Applicants submit that neither Hshieh '128 nor Williams '533 contemplate a transistor wherein a doped heavy body region with the claimed characteristics in relation to other features of the device can operate to improve the breakdown voltage of the transistor. Both these references attempt to address the breakdown problem and both offer fundamentally different solutions. Thus, no combination of these references teaches the present invention as claimed. Withdrawal of this rejection is respectfully requested.

New Claims

New claims 97-120 have been added to claim embodiments of the invention that were not previously adequately claimed. Applicants submit that no new matter is introduced by these claims, and all claims are fully supported by the specification as originally filed. Applicants further submit that independent claim 97 sets forth features that are patentable over the cited references. For example, claim 97, recites in part:

> a doped heavy body region having dopants of the second conductivity type and extending into the doped well to form a heavy body junction at a depth that is deeper than the source junction and shallower than the trench, the doped heavy body region having a region of high dopant concentration near the junction with the doped well and a region of relatively low dopant concentration near the surface of the substrate.

Support for this language can be found at, for example, page 9, lines 24-28, of the application as originally filed (end of paragraph 40 in substitute specification). None of the cited references, nor any combination thereof, teaches or suggests a trench transistor having the claimed "heavy body" with the recited characteristics.

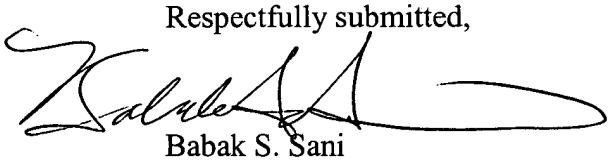
Applicants respectfully submit that all claims presented herein are therefore patentably distinguished over the art or record.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,



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Attachments
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Amendments to the Drawings:

The attached sheet of drawings including Figures 2A and 2B replaces the original sheet including Figure 2. A marked-up sheet indicating these changes is also attached.

Attachment: Replacement Sheet
Annotated Sheet Showing Changes

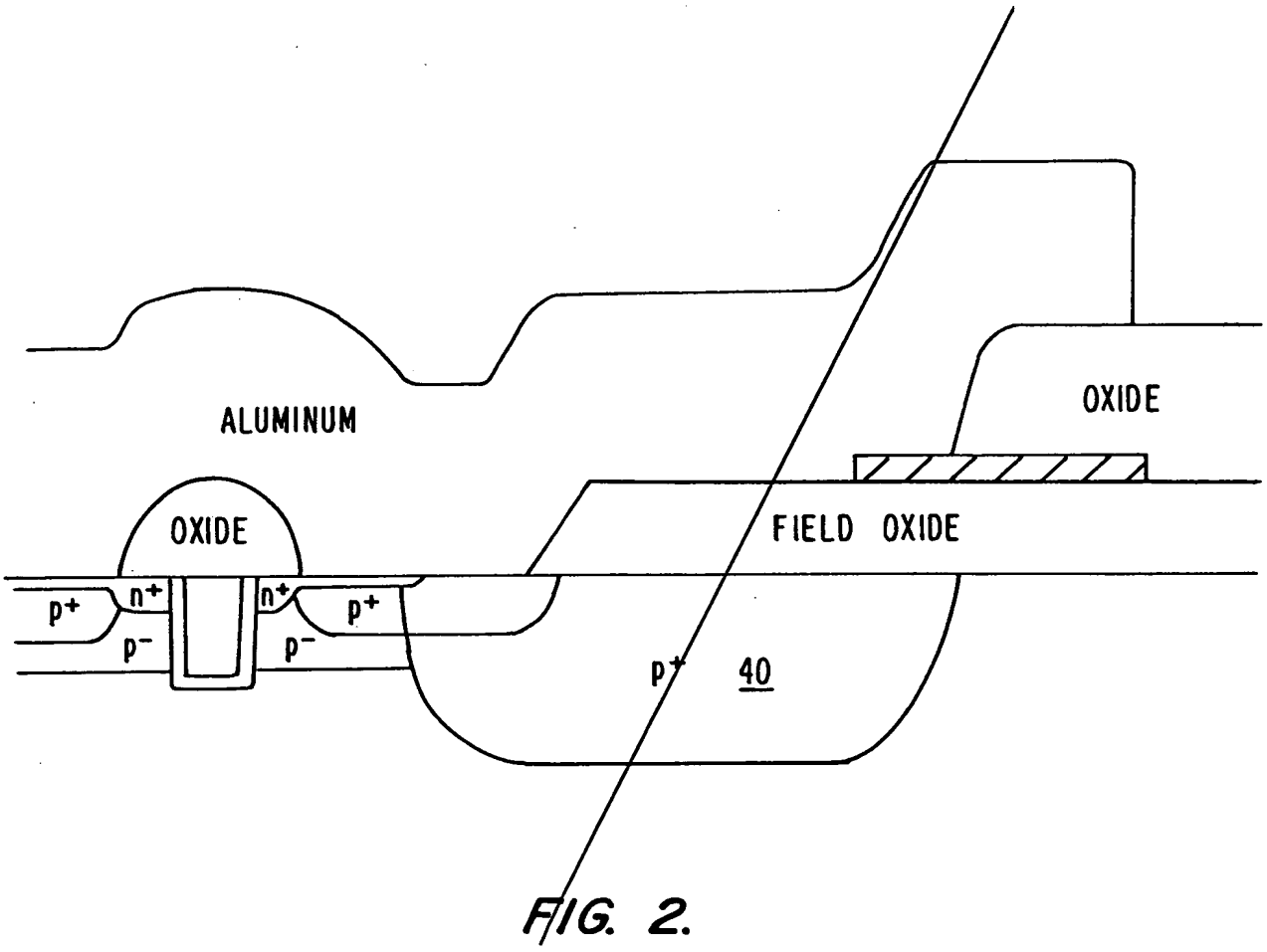

FIG. 2.

FIG. 2A

FIG. 2B